REMARKS/ARGUMENTS

Claims 1, 2, 4 and 9 were pending. Claims 1, 2, 4 and 9 are rejected. No claims were merely objected to and no claims were allowed. By entry of this amendment, claim 2 is canceled without prejudice, claim 1 is amended, and new claims 10-15 are added. Support for the new claims may at least be found in the specification, claims and drawings as originally filed. No new matter is presented.

Rejection under 35 U.S.C. §102(b)

The examiner asserts claims 1, 2 and 4 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S.P.N. 4,780,270 to Hundal et al. ("Hundal").

Applicants' amended independent claim 1 to incorporate the subject matter of dependent claim 2.

Applicants' amended claim 1 recites the following:

> 1. A direct pool cooling type passive safety grade decay heat removal method for a liquid metal reactor,
>
> wherein the liquid level difference between a hot pool defined above a core and inside a reactor baffle and a cold pool defined between the reactor baffle and the inner wall of a reactor vessel is maintained by a primary pumping head under normal steady-state conditions, the interior of the reactor vessel being partitioned into the hot pool and the cold pool by the reactor baffle,
>
> wherein a sodium-sodium heat exchanger connected to a sodium-air heat exchanger mounted above a reactor building via a heat removing sodium loop is disposed at a position higher than a liquid level of the sodium in the cold pool under normal steady-state conditions,
>
> wherein the liquid level of sodium in the cold pool rises so that the liquid level difference between the hot pool and the cold pool is eliminated when the primary pump is automatically tripped due to a failure of a normal heat removal system, and the sodium in the hot pool is expanded due to core decay heat so that the sodium in the hot pool overflows

into the cold pool to form natural circulation flow paths between the hot pool and the cold pool, whereby the sodium-sodium heat exchanger makes direct contact with hot sodium so that the core decay heat is discharged into a final heat sink, the atmosphere, wherein at least one circular vertical tube is disposed in the hot pool inside the reactor baffle, the circular vertical tube has the lower end communicating with the cold pool so that the sodium in the circular vertical tube has the same liquid level as the liquid level of the sodium in the cold pool, and the upper end extended upward to the extent that it is placed at the position higher than a liquid level of the sodium in the hot pool under the normal steady-state conditions,

wherein the sodium-sodium heat exchanger is disposed in the circular vertical tube while it is placed at the position higher than the liquid level of the sodium in the cold pool under the normal steady-state conditions,

wherein heat transfer only by thermal radiation is performed between the inner circumference of the circular vertical tube and the sodium-sodium heat exchanger under the normal steady-state conditions so that solidification of the sodium in the heat removing sodium loop is prevented, and wherein the heat transfer by thermal radiation is quantitatively controlled by adjusting surface emissivity of the sodium-sodium heat exchanger and the circular vertical tube to minimize heat loss under the normal steady-state conditions so that the minimum amount of heat necessary to prevent solidification of the sodium is supplied to the heat removing sodium loop,

wherein the reactor vessel is also cooled by using a passive vessel cooling system.

With respect to rejection of claim 1 under 35 U.S.C. §102(b), as presented in Applicants' amended claim 1 and Figure 8 of the specification-as-filed, the decay heat removal system removes decay heat additionally by means of the passive vessel cooling system (PVCS) together with a sodium-sodium exchanger. Applicants' claimed method also has additional heat removal effect since using the passive vessel cooling system also cools

hot sodium as the hot sodium directly contacts the wall of the container flowering over a baffle toward the container under abnormal operating circumstances. Such teachings are not disclosed by Hundal.

In contrast, Hundal teaches employing an insulating gas space (98) located outward annular space (93) in combination with an auxiliary heat exchanger to prevent the heat exchange between the upper portion of the reactor vessel (3) and hot liquid sodium in the hot pool plenum (41) (see column 8, lines 20-28). Therefore Hundal does not disclose additional decay heat removal using Applicants' PVCS as recited in Applicants' amended claim 1 in case of failure of the normal heat removal system.

In addition, the enablement requirements of the PVCS recited in Applicants' claimed method are sufficiently supported in the specification-as-filed and Fig. 9. Also if you refer to Fig. 8, the present invention has technical feature of additionally removing decay heat by PVCS. More particularly, this feature is not disclosed in the teachings of Hundal.

Applicants shall also address the present rejection in view of new claims 10-15.

Hundal teaches an improved shut-down heat removal system for a liquid metal nuclear reactor that includes an auxiliary heat exchange means, and a passively operated means for bringing the heat exchange means into thermal contact with the liquid metal in the reactor whenever the reactor pump ceases to create a pressure differential between the hot and cold sodium pools contained therein (col. 3, ll. 21-28). Hundal teaches both embodiments of the invention provide a system for removing the decay heat in a liquid metal reactor through entirely passive mechanisms that are triggered and operated as a result of changed pressure conditions between hot and cold pools which naturally result from a partial or total failure of the primary

reactor pump (col. 4, ll. 40-46). Hundal teaches that if a primary pump ever fails to create the pressure differential between the sodium in the hot and cold plenums, the level of sodium will rise and substantially and/or completely immerse the all of the pipes forming the heat exchanger, which in turn would cause the heat exchanger to immediately begin to conduct a substantial amount of heat out of the reactor system and through the stack of the flue (col. 8, l. 63-col. 9, l. 32). In an alternative embodiment, Hundal teaches employing a piston member that falls, upon cessation of the primary pump, and assumes the position illustrated in FIG. 3A thus permitting liquid sodium to flow freely through the inlet ports and immerse substantially and/or completely the helical coils of the heat exchanger (col. 10, l. 46-col. 11, 21).

Applicants' new independent claim 10 recites the following:

> 10. A process for removing decay heat from a liquid metal reactor, comprising:
>
> transferring a quantity of sodium from a sodium-air heat exchanger into a sodium-sodium heat exchanger disposed within a circular vertical tube of a liquid metal reactor;
>
> altering a density of said quantity of sodium via a heat transfer occurring between a quantity of hot sodium located outside said sodium-sodium heat exchanger and said quantity of sodium within said sodium-sodium heat exchanger;
>
> circulating a quantity of density altered sodium through said sodium-sodium heat exchanger to return to said sodium-air heat exchanger; and
>
> removing a quantity of decay heat from said liquid metal reactor.

Hundal fails to teach all of the elements recited in Applicants' independent claim 10. First, Hundal does not teach circulating a quantity of sodium through a heat exchanger disposed within a liquid metal reactor. Secondly, Hundal does not teach altering a density of the quantity of sodium in order to ultimately

achieve removing decay heat. Thirdly, Hundal does not teach circulating a quantity of sodium through a heat exchange by utilizing the difference in density between hot sodium and cold sodium. Lastly, Hundal does not inherently teach the quantity of density altered sodium acts as a medium to remove a quantity of decay heat from the liquid metal reactor.

For at least these reasons, Applicants contend new independent claim 10 is not anticipated by the teachings of Hundal.

Furthermore, Applicants contend claims 1, 4 and 9-15 are not anticipated by the teachings of Hundal for the aforementioned reasons.

In light of the foregoing, Applicants respectfully request the examiner withdraw the rejection under 35 U.S.C. §102(b) and find that claims 1, 4 and 9-15 are patentable.

Rejections under 35 U.S.C. §103(a)

The examiner asserts claims 1, 2 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S.P.N. 4,115,192 to Jogand ("Jogand") in view of U.S.P.N. 4,780,270 to Hundal et al. ("Hundal"). The examiner also asserts claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over U.S.P.N. 4,115,192 to Jogand ("Jogand") in view of U.S.P.N. 4,780,270 to Hundal et al. ("Hundal").

Applicants have amended independent claim 1 to incorporate the subject matter of dependent claim 2.

With respect to rejection of claim 1 under 35 U.S.C. §103(a), Hunland does not teach, suggest or provide the requisite motivation to alter the teachings of Jogand and teach the completely passive concept embodied by Applicants' claimed methods. That is, Jogand teaches the sodium level is maintained

by the pressure of the neutral gas. Therefore, the combined teachings Jogand in view of Hundal does not teach, suggest or provide the requisite motivation to one of ordinary skill in the art to alter their combined teachings and teach the Applicants' amended claim 1.

Also, it is not obvious for a person of ordinary skill in the art to combine with Hundal's full passive decay heat removal system because Jogand's invention is not full passive decay heat removal system.

As presented in Applicants' amended claim 1, through the edge of separating plate (125), a hole is made at the lower end of a circular tube that accepts a sodium-sodium heat exchanger while the circular tube vertically passes through the border plane between the hot pool and the cold pool, which directly communicates with the cool pool. On the contrary, Hundal teaches a closed lower end (90, 80, 86) of a well including a heat exchanger. However, it is connected with the cool pool through a separate flow port (88). In Figure 1, they are connected with a cold plenum by forming a flow port (88) on the side of a well. Yet, in consideration of the arrows representing flowing route of sodium in Figure 1, it is deemed that sodium in the cold plenum flows toward the annular space(93) due to breakdown of the primary pump. Accordingly, such teachings of Hundal directly contravene Applicants' amended claim 1 in which sodium in the cool pool flows into the hot pool due to natural circulation. And as a circular tube recited in Applicants' amended claim 1 directly communicates with the cold pool, in case of a failure of a normal heat removal system, convection current is generated when sodium in the hot pool overflows into the cold pool of the lower end of the circular tube because the temperature of sodium drops as the sodium in the hot pool flows into the circular tube and contacts the sodium-sodium heat exchanger, thus resulting in

a density increase.

On the other hand, when looking at the teachings of Hundal, the lower end of a well is stopped, and only a flow port (88) is formed on the side of the well in the reference invention. Therefore, convection current cannot be generated because pneumatic resistance, that is, a factor that prevents sodium from flowing as known to one of ordinary skill in the art, is too big for sodium to overflow into the cold pool although sodium in the hot pool overflows into the cold pool through the upper end of the well. In case of a failure of a normal heat removal system, Hundal teaches heat can be removed only by heat conduction, that is, a phenomenon in which heat of sodium in the hot pool is taken by contacting with a heat exchanger, because it is just like a heat exchanger is contained in the hot pool. However, in case that there is convection current of sodium as stated in Applicants' amended claim 1, heat can be removed by convection current as well as by heat conduction because sodium in the hot pool overflows into the cold pool directly. In case of heat removal by convection current, sodium with dropped temperature by contacting a heat exchanger goes down to the cold pool, so hot sodium continuously remains in contact with the heat exchanger.

Lastly, Jogand uses neutral gas in order to maintain liquid level difference of sodium in the intermediate space with auxiliary exchanger (35) within it. Accordingly, Jogand does not disclose full passive decay heat removal system since decay heat is removed by an auxiliary exchanger by discharging neutral gas of the intermediate space pursuant to certain type of signal (not disclosed by Jogand) when circulating pumps (18) stop as taught by Jogand. Therefore, the passive decay heat removal system being utilized as recited in Applicants' amended claim 1 cannot be disclosed in spite of the combined teachings of Jogand

in view of Hundal.

As a result, Applicants have discovered that heat removal methods recited in Applicants' claimed methods can remove heat at a significantly quicker speed than the methods employing the heat removal structure disclosed in the combined teachings of Jogand in view of Hundal.

Applicants shall also address the present rejection in view of new claims 10-15.

Applicants reiterate their remarks concerning the teachings of Hundal with respect to new claims 10-15.

Jogand teaches an improvement made to the inner structures of a fast neutron nuclear reactor, which makes it possible to ensure in the case of a fault in the reactor that the residual heat is removed through the provision of a liquid metal circulation by natural convection (col. 1, ll. 58-63). Jogand teaches the improvement is the upper end of the inner vessel is covered by an inverted annular bell cap and is placed under the internal pressure of a neutral gas in order to prevent in normal operation direct communication between the hot liquid metal within the inner vessel and the cold liquid metal in the annular space between the main vessel and the inner vessel (col. 1, l. 64-col. 2, l. 3). Jogand teaches that if the pumps are damaged and the circulation of sodium in the exchangers stops, the pressure of the neutral gas below the bell cap is decreased and sodium circulation takes place directly by natural convection above the edge of the upper end of the inside of the vessel towards the outside, thus circulating in contact with the tubes of the auxiliary exchanger and leading to the adequate cooling of the sodium to permit an appropriate removal of the residual heat (col. 3, l. 57-col. 4, l. 15). In an alternative embodiment illustrated in FIG. 2, Jogand teaches utilizing an inverted bell cap associated with an auxiliary exchanger which

although is structurally different than the primary embodiment, essentially functions in the same manner to permit the appropriate removal of the residual heat (col. 4, ll. 17-28).

Applicants' new independent claim 10 recites the following:

> 10. A process for removing decay heat from a liquid metal reactor, comprising:
>
> transferring a quantity of sodium from a sodium-air heat exchanger into a sodium-sodium heat exchanger disposed within a circular vertical tube of a liquid metal reactor;
>
> altering a density of said quantity of sodium via a heat transfer occurring between a quantity of hot sodium located outside said sodium-sodium heat exchanger and said quantity of sodium within said sodium-sodium heat exchanger;
>
> circulating a quantity of density altered sodium through said sodium-sodium heat exchanger to return to said sodium-air heat exchanger; and
>
> removing a quantity of decay heat from said liquid metal reactor.

Jogand fails to teach all of the elements recited in Applicants' independent claim 10. First, Jogand does not teach circulating a quantity of sodium through a heat exchanger disposed within a liquid metal reactor. Secondly, Jogand does not teach altering a density of the quantity of sodium in order to ultimately achieve removing decay heat. Thirdly, Jogand does not teach circulating a quantity of sodium through a heat exchange by utilizing the difference in density between hot sodium and cold sodium. Lastly, Jogand does not inherently teach the quantity of density altered sodium acts as a medium to remove a quantity of decay heat from the liquid metal reactor.

For the aforementioned reasons, Hundal fails to cure the deficiencies present in the teachings of Jogand. The combined teachings of Jogand in view of Hundal fail to teach, suggest or provide the requisite motivation to alter their teachings and teach all of the claim elements of Applicants' independent claim

10.

For at least these reasons, Applicants contend independent claim 10 is patentable and not obvious in light of the combined teachings of Jogand in view of Hundal.

Furthermore, Applicants contend claims 1, 4 and 9-15 are patentable and not obvious in light of the combined teachings of Jogand in view of Hundal for at least the aforementioned reasons.

In light of the foregoing, Applicants respectfully request the examiner withdraw the rejections under 35 U.S.C. §103(a) and find that claims 1, 4 and 9-15 are allowable.

CONCLUSION

In light of the foregoing, it is submitted that all of the claims as pending patentably define over the art of record and an early indication of same is respectfully requested.

An earnest and thorough attempt has been made by the undersigned to resolve the outstanding issues in this case and place same in condition for allowance. If the Examiner has any questions or feels that a telephone or personal interview would be helpful in resolving any outstanding issues which remain in this application after consideration of this amendment, the Examiner is courteously invited to telephone the undersigned and the same would be gratefully appreciated.

It is submitted that the claims as amended herein patentably define over the art relied on by the Examiner and early allowance of same is courteously solicited.

If any fees are required in connection with this case, it is respectfully requested that they be charged to Deposit Account No. 02-0184.

Respectfully submitted,

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